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REPORT APRE 1/73



"ASSESSMENT OF THE EFFECTS OF  
WEARING FULL NBC PROTECTIVE  
CLOTHING AND EQUIPMENT ON THE  
MILITARY PERFORMANCE OF ALL ARMS" (C)

(EXERCISE JEREMIAH)

VOLUME 1

by

ARMY PERSONNEL RESEARCH ESTABLISHMENT

together with

DEFENCE NBC SCHOOL

&

CHEMICAL DEFENCE ESTABLISHMENT

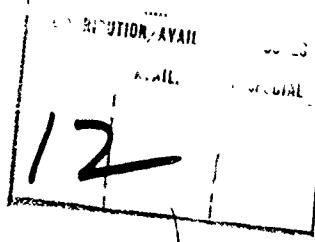
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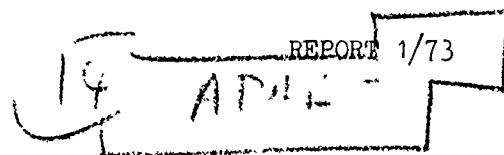
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⑦ ASSESSMENT OF THE EFFECTS OF WEARING FULL NBC PROTECTIVE CLOTHING AND EQUIPMENT ON THE MILITARY PERFORMANCE OF ALL ARMS

(EXERCISE JEREMIAH).

VOLUME I [c].

by

⑦ 37 P.

ARMY PERSONNEL RESEARCH ESTABLISHMENT

together with

DEFENCE NBC SCHOOL and CHEMICAL DEFENCE ESTABLISHMENT

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REPORT 1/73

"ASSESSMENT OF THE EFFECTS OF WEARING FULL NBC PROTECTIVE CLOTHING AND EQUIPMENT ON THE MILITARY PERFORMANCE OF ALL ARMS"

(EXERCISE JEREMIAH)

VOLUME I

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ARMY PERSONNEL RESEARCH ESTABLISHMENT

together with

DEFENCE NBC SCHOOL and CHEMICAL DEFENCE ESTABLISHMENT

 PREFACE

Exercise Jeremiah was a tactical exercise designed so that an assessment could be made of the effects of wearing full NBC protective clothing and equipment on the military performance of an All Arms group.

The report is issued in two volumes. Volume I contains a broad summary of the exercise, its limitations, results obtained and conclusions and recommendations. Volume II contains details of methodology and supporting data.



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"ASSESSMENT OF THE EFFECTS OF WEARING FULL NBC PROTECTIVE CLOTHING AND EQUIPMENT ON THE MILITARY PERFORMANCE OF ALL ARMS"

(EXERCISE JEREMIAH)

VOLUME I

by

ARMY PERSONNEL RESEARCH ESTABLISHMENT

together with

DEFENCE NBC SCHOOL and CHEMICAL DEFENCE ESTABLISHMENT

INTRODUCTION

BACKGROUND

1. Early in 1970 GS(OR)4 Branch of the Ministry of Defence (Army Department) posed the following problem to Army Personnel Research Establishment (APRE):

"GS(OR)4 propose that a study be made of the effects on the military performance of All Arms wearing full NBC protective clothing and equipment on a battlefield continuously contaminated by CW Agent".

2. A feasibility study, conducted by APRE, showed that it would be necessary to conduct a realistic military exercise in which an All Arms group took to the field, in a simulated toxic environment. The exercise was to be supervised by a combination of military umpires and scientific observers. The emergency in Northern Ireland pre-empted the exercise planned for 1971 and it was eventually conducted in 1972.

AIMS

3. The Aims of Exercise Jeremiah were:

- a. To study the effect on the military performance of All Arms wearing full NBC protective clothing and equipment on a battlefield continuously contaminated by chemical agents;
- b. To decide the extent to which a well trained soldier can live and fight in a toxic environment with the equipment now available;
- c. To determine the need for collective protection for rest and relief purposes.

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METHOD

FORCES TAKING PART

4. a. Friendly Forces: a Combat Team, comprised of a mechanised infantry company with an armoured troop and elements in support was assembled from the following units:

2nd Battalion The Royal Anglian Regiment  
5th Royal Inniskilling Dragoon Guards  
19th Field Regiment Royal Regiment of Artillery  
21st Engineer Regiment Corps of Royal Engineers  
31 Field Ambulance Royal Army Medical Corps  
6 Field Workshop Corps of Royal Electrical and Mechanical Engineers

b. Enemy Forces were provided by elements from:

5th Royal Inniskilling Dragoon Guards  
2nd Battalion The Royal Anglian Regiment

THE SETTING

5. Exercise Jeremiah was conducted in two phases:

- a. Phase I. A pre-exercise fitness and NBC Clothing and Equipment familiarization phase, at Munster and on the Dorbaum Training Area (29th March to 21st April 1972).
- b. Phase II. The Tactical Exercise at Sennelager (24th to 28th April 1972).

PRE-EXERCISE TRAINING PHASE

6. A training programme was devised to ensure that all troops participating were fully familiar with their NBC protective clothing and equipment, and were accustomed to performing their military duties wearing the equipment. The intention of the programme was to improve the soldier's ability to overcome the physiological burden imposed by his NBC equipment. The programme was intensive and included cross country running, an assault course, marching, stores handling and football; each of these activities were practiced with the soldier wearing his respirator. The training also included barrack activities and sleeping in respirators.

7. The physical fitness and equipment familiarization training programme for Exercise Jeremiah, was designed with the following intentions:

- a. Measure the initial physical fitness standard as determined by the number of circuits, round a 200 metre track, achieved in twelve minutes. The troops were required to demonstrate maximum work effort by achieving a heart rate, at the end of the twelve minutes or on stopping running, of 180 beats per minute.

- b. Measure the initial running capability of troops, attired in NBC protective clothing and respirators, on the 200 metre track.
- c. Improve the initial performance, as at 'b' above, by means of physical fitness training in various military and sporting activities, viz: marching, assault course, cross country runs, carrying and loading stores, football.
- d. Overcome any possible limitations through incorrect use of the NBC protective clothing and equipment.
- e. Repeat steps 'a' and 'b' as a means of demonstration of possible improvement in performance.

8. During the planning of Exercise Jeremiah it was realised that the act of donning NBC protective clothing and equipment was, to many soldiers, a novel experience. The equipment's restrictive effects, compounded by a lack of familiarity, could easily have prejudiced the efficient use of the equipment thereby causing unwarranted criticism and a lack of confidence in the concept of personal protection afforded.

9. Familiarization training with NBC protective clothing and equipment was considered to be as essential to success as other aspects of basic arms training and skills. In the face of a toxic threat the soldier, untrained and unfamiliar with his NBC protective equipment, will rapidly become a casualty.

10. A special effort was made to ensure that all members of the Combat Team had reached the standard of individual NBC defence training as defined in NBC Defence Training Pamphlet No 8, viz:

- a. the use of his personal issue NBC defence clothing and equipment and in those NBC defence procedures and drills carried out by him for his personal protection, and in
- b. the use of NBC defence equipment other than personal issue equipment, and in NBC defence procedures and drills not connected with personal protection, such as chemical reconnaissance or radiological survey.

11. During the period the Combat Team were conducting 'work-up' training on the Dorbaum Training Area, the umpires and observers were given additional briefing on the conduct of the exercise and given practice in assessing the various activities requiring special attention throughout the exercise period. An afternoon was also devoted to a series of lectures, on chemical defensive measures, for the umpires.

#### SCENARIO FOR THE "TOXIC THREAT"

12. Discussions were held between the contributing Establishments, the Royal School of Artillery, and other authorities, in order to formulate a working hypothesis on which to base a scenario for the

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"toxic threat". How was the statement in the original problem (para 1) "A battlefield continuously contaminated by a chemical agent" to be interpreted?

13. It was decided to prepare a "fire plan", for chemical attacks, which would cause the Combat Team to be forced into a masked posture for approximately one third of the exercise period, after each chemical strike, the masking period to be further determined by the degree of contamination and persistence of the agent being simulated.

THE EXERCISE

14. Exercise Jeremiah was a five day tactical exercise based on 'Battle Group Tactics in Germany' and, for control purposes, was divided into ten operations viz:

- a. OPERATION ONE, DEFENCE OF THE HAUSTENBECK LINE  
240600 HRS TO 250400 HRS
- b. OPERATION TWO, COUNTER PENETRATION ATTACK  
250430 HRS TO 251000 HRS
- c. OPERATION THREE, ROAD MOVEMENT UNDER ATTACK BY PERSISTENT AGENT  
251010 HRS TO 251230 HRS
- d. OPERATION FOUR, DEFENSIVE POSITIONS WAGNERHOF  
251300 HRS TO 261000 HRS

Including

- e. OPERATION FIVE, PATROL PROGRAMME NIGHT 25/26  
251945 HRS TO 260700 HRS
- f. OPERATION SIX, WITHDRAWAL PHASE  
261015 HRS TO 270200 HRS
- g. OPERATION SEVEN, COUNTER AMBUSH  
270200 HRS TO 270300 HRS (APPROX)
- h. OPERATION EIGHT, VILLAGE CLEARING AND PATROLS  
270300 HRS TO 271500 HRS
- i. OPERATION NINE, COUNTER PENETRATION ATTACK (REPEAT OF OP 2)  
271500 HRS TO 272359 HRS
- j. OPERATION TEN, VILLAGE FIGHTING  
280001 HRS TO 280930 HRS

CHEMICAL STRIKES

15. The first chemical attack by the enemy came on the first day of the exercise and attacks continued throughout the exercise with a total of 16 strikes against the Combat Team. Twelve of these attacks simulated non-persistent nerve agent attacks and four simulated persistent agent attacks. This was a tactically realistic

level of attack which resulted in all troops being masked for more than a third of the exercise.

#### OBSERVER AND UMPIRE TEAM

16. An observer-umpire team and exercise staff were provided by BAOR, and by each of the contributing Establishments, and their assessment of the exercise and the NBC defensive equipment placed considerable reliance on the technique of multiple choice questionnaires. The following points received special attention:

- a. Ability of commanders to maintain command and control.
- b. Communications.
- c. Ability to identify and engage targets.

17. A total of twenty-nine different questionnaire sheets were administered by APRE alone, some of them twice daily, and these were of four different types:

- a. Human factors aspects.
- b. Tactical assessment.
- c. Specific to Arm (eg RE and RA tasks)
- d. General.

18. As an aid to determining the day to day effect on command performances of wearing full NBC protective clothing and equipment, a number of tests of mental ability were administered, twice daily, to all members of the Combat Team who had command responsibilities and on the occasions the tactical play was halted.

#### MONITORING OF COMMUNICATIONS

19. As it was considered that radio communications might be a specific area where individual decrements in performance (as determined by wrong messages, poor procedure, lack of attention to security etc) could possibly be detected, it was decided to monitor and record the exercise radio traffic.

#### LIMITATIONS

#### GENERAL COMMENT ON PROBLEMS EXPERIENCED WITHIN THE SETTING AND FRAMEWORK OF THE EXERCISE

20. It was appreciated that problems would occur throughout the exercise in maintaining realism and true activation. These problems can be summarised as follows:

##### Realism

- a. Realism within the time frame and physical limitations of the Sennelager Training Area.

- (i) Of necessity, exercises tend to be faster than war.
- (ii) Individuals react to situations on training exercises very differently than when faced with real dangers and casualties. A degree of over-motivation was apparent.

#### Size of Training Area and Chemical Simulation

- b. The size of the training area available was approximately a rectangle 3km by 6km and some ingenuity and unrealism was needed to keep the exercise within these confines. CS was used to simulate all non-persistent chemical attacks and, as it has a long downwind travel, the quantities and concentration of CS that could be used in the training area were small and in no way reflected a combat situation. There were also limitations in the chemical simulation in that:
  - (i) CS, at its point of generation, is visible unlike most real agents.
  - (ii) CS is detectable by the nose, unlike most real agents.
  - (iii) CATM used to simulate liquid attack, marks detector paper but does nothing else.
  - (iv) The air delivery of CATM was by helicopter which is unrealistic.
  - (v) Considerations for the ecology and future users of the training area required extreme care in the use of chemical simulants, thus restricting tactical flexibility of the chemical challenge and limiting the exercise area accordingly.

#### Interpretation of Task

- c. Problems of Interpretation of the Task.
  - (i) The awareness of the soldiers of the aims of the trial and their willingness to cooperate reduced the need for excessive "picture painting" as situations developed.
  - (ii) Care was essential, nevertheless, to ensure that Flank Formation information and other intelligence collection was imaginatively coordinated by the Exercise Control staff, Umpires and Observers.
  - (iii) Difficulty in the identification of the toxic hazard was experienced due to the limitations of the training expedients employed.

Unit SOPs

- d. SOPs for NBC defensive drills required revision as the exercise progressed.

Non-Participant Congestion

- e. The Umpire, Observer, Chemical Release and Battle Simulation Teams and their many vehicles caused unrealistic battlefield congestion. The unavoidable presence of so many extra people, although bearing identifying armbands and vehicle signs, cluttered up the exercise area, provoked speculation about impending "enemy" activity, and generally confused the military subjects in the performance of their prime military duty.

Unintentional Stresses

- f. The imposition of additional stresses on the Combat Team and individual subjects was noted. It became obvious that measurement of human performance degradation and deterioration in performance assessments were being prejudiced by the very act of measurement. Examples are situations such as men postponing natural functions to avoid the embarrassment of being observed and occasions when they were confused by the administration of psychological tests using different radio callsigns and phraseology. Similarly, lower levels of command and supervision were unable to order or oversee routine tasks in the field, because of the need to administer questionnaires and tests at NCO level during the very moments of respite when such activities are performed.

Rest and Relaxation

- g. Enemy activities were not known to Friendly Forces and so rest could not be planned. When opportunities for rest did occur, the presence of observers and visitors created problems. This was especially noticeable amongst commanders who were themselves under an obligation to do well to oblige their superiors and not to betray their own men by any personal shortcoming or inadequacy. (ie The Confidential Report Syndrome). Since the enemy activities were not known to the friendly forces, planned periods of rest were, of course, out of the question.

Lack of Control for Comparison

- h. During the planning stages it was emphasised that it would be impossible to quantify or rationalise the reactions of a Combat Team, either at command, platoon or section level. Ideally a comparison of the Combat Team responding to military problems, in a conventional setting, with their response in a toxic environment would have provided data for objective analysis. However, it was not possible, nor

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practical, to perform each phase of the exercise twice, and indeed, to have done so would have rehearsed for the second attempt and thus prejudiced the result by familiarization or by fatigue.

Unit Training State

i. The exercise had to be held in the Spring of 1972. Because the training cycle of the 2 R Anglian in common with other units in BAOR is tuned to individual training in the early months of each year, culminating with Company Group and Battle Group Training in the late Summer and Autumn, and also, because of the demands for emphasis on Internal Security and Counter Insurgency type training due to the turbulence of Ulster, the exercise troops had done little in the 1972 season toward Section, Platoon and Other Arm collective training and had not previously trained together as a Combat Team.

Role of Participating Units

j. Lastly, it is very relevant that the participating units do not group into a Combat Team for their present role. Although the tactical problems presented during the trial were within the professional competence of the team members, they were not within their normal training experience. The provision by BAOR of a trained integrated Combat Team may have reduced some of the problems encountered.

NON-EXEMPTION OF SUPPORTING TROOPS

21. Early in the exercise there were individuals who considered that their cap badge merited special exemption from NBC defensive measures. All subsequently realized that a potential enemy employing chemical agents would not recognise any "divine right of tradesmen".

22. There is, however, as this misconception shows, a need to inculcate a better understanding of the NBC threat amongst all Arms and Services who may not fully appreciate the chemical hazards.

23. There was also, a marked tendency at the beginning of Exercise Jeremiah to assume that basic tactical drills, relating to security, camouflage, track discipline, weapon handling and defensive disciplines were an Infantry or 'teeth' arm prerogative. There is obviously a need to balance trade training and combat training to achieve a true proportion.

FIELDCRAFT AND COMBAT DRILLS

24. In making a military assessment of the performance of the Combat Team on the exercise it was known that there would be no objective criteria nor yardsticks for the potential of the particular Combat Team under examination, and that all comments on tactical performance would need to be subjective and could not be comparative with previous performances.

## RESULTS

RESULTS, PHASE I - PRE-EXERCISE TRAINING

25. The results of the initial physical fitness standard, as determined by the number of circuits round a 200 metre track, achieved in twelve minutes, are given in Table 1. The results obtained at the end of the training phase are displayed in the same table. The troops were attired in physical training kit. The final standard achieved by all participants was good and indicated the measure of cooperation and achievement which was evident through the pre-training period and the tactical exercise.

26. Group D, comprising the armour and artillery elements, demonstrated the most significant improvement in the results obtained performing the test attired in physical training kit. Group A's improvement in performance was not significant. The improvement in the standard of physical fitness demonstrated by Groups B and C was significant at the 1 per cent and 5 per cent levels, respectively.

INITIAL AND FINAL FITNESS ASSESSMENT TEST, PT KIT

Group	Distance covered in Metres		Initial/Final Difference	Significant Difference
	Initial	Final		
A, Infantry	3100	3200	100	NS
B, Inf + LAD sect	3040	3200	160	1%
C, Spt Wpns, Engrs and Fd Amb	3027	3117	90	5%
D, Armour and Fd Regt	3004	3141	137	0.1%

Table 1

27. Compared with their initial test all four groups demonstrated a significant improvement in the distance covered, in their final test, attired in respirators and NBC protective clothing less overboots. (Table 2).

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INITIAL AND FINAL ASSESSMENT TEST, WEARING RESPIRATORS AND NBC KIT

Group	Distance covered in Metres		Initial/Final Difference	Significant Difference
	Initial	Final		
A	2381	2636	255	0.1%
B	2303	2443	140	0.1%
C	2352	2459	107	1%
D	2074	2496	422	0.1%

Table 2

28. Except for Group A some of the improvement demonstrated is attributable to a general improvement in physical fitness.

29. Practice during the pre-exercise training period produced no significant differences in respirator donning time. The drill was executed on an anticipated order of command and conducted both before and after periods of exercise. The average time returned was the remarkably short one of six seconds.

30. Breath holding was measured before and after exercise, and the mean time obtained immediately after an exercise session was 11.9 seconds. The margin between respirator donning time and breath holding capability is slender. The times given are for ideal conditions; with fatigued troops the reaction time and respirator donning time would be longer, the breath holding capability less, and the margin even more slender.

31. The programme for the pre-exercise training phase included specific to arms tasks, eg artillery and armour competitive drills. Emphasis was placed on inter-group and inter-crew competitive spirit and there were occasions when the times returned for drills completed in NBC ensemble were faster than the same group conducting the drill clad in their normal combat dress.

TROOPS' STATE OF HEALTH

32. All troops taking part were examined by medical officers before and after the exercise. Selection for fitness to participate was conducted by the unit RMO prior to the pre-training phase.

33. The level of medical fitness and morale was high both before and after the exercise. There was, however, marked deterioration in skin condition; this was mainly due to an increase in water content of the outer layers of the skin of feet and hands associated with the water impermeability of the glove assembly and overboots. A similar "maceration" of the sole of the foot is not uncommon when boots DMS

are worn continuously for long periods (eg in N Ireland). However, that a large proportion of the men were seen to acquire this condition in five days must be attributed to the moisture impermeability of the overboots, failure to ensure correct fitting of Boots DMS and inadequate attention to care of feet. Six men had severe maceration of the feet and were in danger of becoming non walking casualties as a consequence.

34. An increase was noted in the number of men having headaches, but this is a feature of any strenuous exercise. However several men attributed their headaches to tight (incorrect fitting) respirator straps, with the pain located in the superficial scalp layer aggravated by movement of the hair.

35. During the exercise 41 men were found to have gained weight and 122 men lost weight. The range was -3.7 to + 2.0 Kg (mean -0.95 Kg).

#### HUMAN FACTORS ASPECTS

36. Sleep. The intensive nature of the exercise is perhaps best revealed by the summary of observed sleeping hours, Table 3; the observed hours of sleep correlate well with the answers from a larger sample of the troops given to the sleep Questionnaire.

Table 3

Component	0900-2100 hrs	2100-0900 hrs
Infantry	1.5	3.3
Armour	1.2	3.5
Echelon	0.7	5.2

Average number of hours sleep

37. For All Arms the overall average of sleep obtained was 3.6 hours by night and 1.3 hours during the day; the averages quoted are not necessarily observations on the same sample of the population and thus the day and night figures should not be summated. The troops only averaged approximately 2.5 hours sleep on each night of days 1 and 2.

38. The main reasons given for not sleeping were, in order, cold and discomfort, respirator and noise. Leaving out the answers relating to duties (ie lack of opportunity) analysis of the reasons for not sleeping is as follows:

	percent
Cold and uncomfortable	46
	(see meteorology data, Volume II)
Respirator	32
Noise	11
Other	11

calculated from a total of one hundred and fourteen soldiers questioned.

#### FLUID CONSUMPTION

39. Analysis of the questionnaires shows an average estimated fluid intake per soldier, per twelve hour period, of 1.8 pints; 6 per cent of those questioned declared no intake in that period. A significantly higher number of Infantry, than Armour or Echelon, complained of being thirsty. Over the whole exercise an average of 50% of the Combat Team complained of being thirsty.

#### MEALS

40. On average 10% of those questioned in each twelve hour period complained of having had no food. There was a marked difference between the number of Infantry (44% average in each 12 hour period) and the figures for Armour (24%) and Echelon (23%) with regard to complaints of insufficient to eat, in the period preceding administration of the Questionnaire. Ten per cent of the troops in receipt of meals complained that the food was not hot, this is a situation typical of any military exercise.

#### OXIME TABLETS

41. The exercise troops were encouraged to take the nerve agent prophylactic treatment of oxime tablets throughout the exercise, though this was not compulsory. The tablets were in a standard pack and the correct dose required that 4 tablets be taken every 6 hours. The number who took the tablets regularly throughout the exercise was a disappointing 27%, but in a chemical attack situation no reluctance to take oximes would be expected. The reasons given for not taking oximes were many and various and are given in Volume II together with details of some of the very mild side effects reported.

#### ASSESSMENT FORM

42. The assessment form was designed to obtain information to determine response to orders, individual morale, care of weapons, physical conditions, drive, attitude to tasks and alertness.

43. The form was completed by observers and umpires, who were with a group of soldiers known to them, and studied by them during the pre-exercise work up training. The observers had been instructed to get to know the individuals they were observing, to examine behaviour pattern during stressful situations and endeavour to look for behaviour out of character. The form was completed after each appropriate and suitable activity, eg section attacks and preparing weapon pits.

44. The analysis of the data collected can be best summarised as:

a. Response to Orders

There was a significant deterioration in response during the course of the exercise (at the 0.1% level). On the first day "promptly" and "fairly quickly" accounted for 96% of the answers. By the fourth day "without haste" and "slowly" accounted for 39% of the replies.

b. Handling of Weapons

There was a significant deterioration (at the 0.1% level) during the exercise. On the first day there were no responses recorded in the 'bad' categories whilst on the fourth day, this end of the scale contained 20% of the responses.

c. Moving Away from Weapons

There were no significant differences between days; a response of "yes" appears for 28% of observation.

d. Carrying Respirator

There were no significant differences between days; there were 11% of occasions (ie of observations made when questionnaire forms and diaries were being compiled) when troops were reported as being seen not carrying a respirator.

e. Physical Condition

The answers to the Questions on physical fitness show a deterioration, significant at the 0.1% level, over the period of the exercise.

f. Drive or Effort

There is a deterioration significant at the 0.1% level, although, even on the last day the proportion of responses in the lower end of the scale is very small (the category headings at this end of the scale were: 'needs driving', 'skiving' and 'minimum effort possible').

g. Attitude to Task

The deterioration is again significant at the 0.1% level with the change from 75% "enthusiastic" or "keen" on Day 1 reducing to 16% on the fourth day. The proportion of scores in the lower end of the table is again gratifyingly small.

h. Alertness and Awareness

A deterioration significant at the 0.1% level, with only 2% in the lower two categories ('not much notice of what is

'going on' and 'oblivious of surroundings') on the first day changing to 52% on the fourth day.

1. Individual Morale

There was a significant deterioration in individual morale at the 0.1% level. On the first day only 2% are recorded in the lower half of the table, whereas by day four the figure becomes 44% of the responses ('browned off', 'very low spirits' and 'dejected, silent, downcast').

THE EFFECT OF WEARING NBC CLOTHING ON MENTAL PERFORMANCE

45. Stresses such as fear, sleep deprivation, cold and noise are unavoidable features of the battlefield environment. Although there is an acknowledged detrimental effect of stress on judgement and intellectual capacity, in general, mental performance is maintained at a functional level.

46. However, prior to the exercise it was reasonable to speculate that the additional burden of the NBC suit and respirator, might well prove to be the straw that breaks the camel's back. To check whether command performance was likely to suffer, a number of mental tests were administered to troops with command responsibilities, ie lance corporal to major, on each of the first four days of the exercise.

47. The tests examined coding skills required for radio communication, short-term memory, visual processing and abilities reflecting intellectual capacity. Slidex and Codex were used as coding tasks.

48. An analysis of variance was carried out on the results (Table 4) of each test. Performance on the memory test remained constant throughout the week, while the visual and intellectual tests showed evidence of continued learning. However, there was a deterioration in Slidex and Griddle on the second and third days, marked by a drop in both number of items attempted and number correct; although the proportion of correct items remained much the same, almost all men showed a decline in speed rather than accuracy. The decline was followed by a recovery with the "end spurt" of the last day. Although Page's 'L'\* test reflected the trends quite clearly the deterioration was only significant (at the .0% level) for Slidex; difference tended to be obscured by large within-group variations.

\*("Ordered Hypotheses for Multiple Treatments : A Significant Test for Linear Ranks", Journal of American Statistical Association, 58, 1963, 216-230)

Table 4  
MEANS OF PERFORMANCE SCORES

Test	Day 1	Day 2	Day 3	Day 4
<u>Slidex</u> encoding (attempted) (correct)	20.57	12.77	13.40	17.40
	19.71	11.70	12.22	16.54
	12.78	11.11	11.22	12.43
	12.28	10.22	10.66	11.73
<u>Griddle</u> encoding (attempted) (correct)	5.65	5.44	5.59	5.85
	5.60	5.07	5.27	5.64
	5.45	5.03	4.94	5.33
	5.15	4.78	4.53	5.04
<u>Memory</u>	6.35	6.11	6.37	6.21
<u>Visual Test</u>	12.63	14.50	14.80	15.16
<u>Reasoning</u> (attempted) (correct)	33.79	33.93	34.26	39.83
	29.11	29.34	29.91	35.53

DISCUSSION ON MENTAL PERFORMANCE TESTS

49. The number of stressful situations, (eg enemy attacks, chemical attacks, changes in location) to which the men were exposed, varied considerably, some receiving much less stress than others in the Combat Team.

50. This factor and differences in endurance and motivation, meant that a few men were able to show an improvement rather than a decline in performance, probably due to a function of practice despite the attempt in the pre-exercise training programme to raise performance to peak level before testing began.

51. The absence of a control group, ie men working in a similar situation but without the need for NBC protection, makes it difficult to come to any firm conclusion about the effect of the equipment on mental performance. In the present series of tests any decrement was certainly confounded with the effects of practice. It is possible that practice effects would have been greater if NBC protective equipment had not been worn.

52. From the present results it appears that mental stress effects due to living in an NBC environment for five days are neither noticeably cumulative nor very great in magnitude. Admittedly the men were not under maximum stress while being tested, they did not have to wear respirators and were therefore aware that they would not come under chemical attack. This was a morale booster for at least some of the troops. However, had the experience of living in the suit proved to be traumatic, it is unlikely that the effect would

have dissipated in a matter of minutes, and so would have been reflected in the test results.

53. The deterioration would seem most likely to be attributable to a fatigue factor derived from sleep deprivation, boredom, and the load of the NBC protective clothing and respirator - aside from the NBC protection, factors present in any army exercise and which are very much dependent on the events of the day. Certainly the men's alertness and the effort put into their jobs, as given by observer ratings, fell steadily through the exercise period.

54. It is possible that NBC equipment is most open to criticism - with respect to its effect on mental performance - for the limitations the respirator imposes on the amount and quality of sleep obtainable. As previously recorded (para 38) 32% of the troops interviewed cited the respirator as a reason for inadequate sleep. The deterioration observed in performance proved to be commensurate with the effect of moderate sleep deprivation, in that it was manifested more in repetitious, less intellectually demanding and less interesting tasks than in those reflecting decision and command ability, but research has shown that even these are subject to decrement with greater and/or more prolonged sleeplessness. Given the limited hours available for relaxation, and the need for conscientious wearing of the respirator on all occasions when vulnerable to attack, this would seem to make the development of collective protection, or at least individual facilities for sleeping without the respirator a priority area for research. It is also for consideration that the pre-exercise training for the troops to acquire confidence in their ability to sleep in respirators was inadequate.

#### MONITORING OF RADIO COMMUNICATIONS

55. A detachment of 225 Signal Squadron was assigned the task and a team manning 2 VHF monitoring positions was attached to the exercise. The detachment was operational from 240001A to 280900A.

56. Their report is as follows:

- a. "A brief was given to the detachment to monitor the following VHF radio nets
  - (i) Combat Team Command net
  - (ii) Armoured Troop net
  - (iii) Artillery net
  - (iv) Control netand report with reference to
  - (i) Efficiency of the nets
  - (ii) Security

(iii) Possible degradation in efficiency of communications".

- b. Efficiency of the nets. Taking into account the nature of the exercise this was seen to be of a generally high standard. Very little activity was heard on the Armoured Troop net and the Artillery net".
- c. Security. In general the security was good. Communication procedure as laid down was used at all times. The use over the air of the words, special tests, suits, pills, would indicate to the enemy a trial of sorts".
- d. Degradation in Efficiency of Communications. There was no drop in performance due to the wearing of respirator/NBC protective clothing. Communications on the Combat Team net during the final battle at 280600A remained at the same high standard commented on at (b) above".

#### TRAINING STANDARD

57. Considering the standard of training and the lack of group training within the BAOR Training Cycle, very few obvious errors of tactical handling, loss of direction or failure to achieve an aim were seen and, of those that did occur, there is no means of establishing that errors were due to NBC equipment either actually worn or inducing fatigue or distress in some other way. In effect, errors of judgement, poor weapon handling or minor tactical drills, bad camouflage and so on where they did occur, could also have occurred regardless of the wearing of respirators and NBC clothing.

58. It is probable that many more criticisms could have been levelled at other soldiers in similar circumstances, and therefore, it can be concluded that the soldier subjects were "well trained" within the context of what is practical and possible and it can be assumed that such a state of morale, motivation and sustained training state would be exceptional rather than standard.

#### LOSS OF DIRECTION

59. There was one incident of sub-units losing direction. This was due to the failure of a Platoon Commander to identify a ground feature against a known map location. Consequently his platoon dismounted prematurely from their APC thus adding 500 metres or more to his dismounted approach.

60. In addition, the troops advanced over-cautiously and too slowly considering their actual distance (as opposed to assessed) from known enemy locations. This isolated incident was not attributable to group or individual degradation from being masked or wearing NBC protective clothing.

#### MOTIVATION

61. Two factors were relevant:

a. The Duration of the Exercise

For obvious reasons every soldier knew that the exercise would terminate; they all knew and anticipated a hot bath and a hot meal on the 28 April 72. For this reason alone, the challenge to remain masked and clad in NBC protective clothing was merely a question of duration and "sticking it out" in competition with ones' chums.

b. The 'Challenge' Itself

The men, once briefed, were interested personally and professionally. They were proud that they and their unit had been selected. They knew that senior officers and indeed the whole Army were watching their reactions and endurance; they also knew that the 'observer' audience included females and nationals of other countries. Finally, they were in competition with each other and with other arms of the Combat Team as well as being "out on exercise" away from Barrack tasks. As "being set apart" they were determined to show all comers that they could take whatever was to be meted out.

## MILITARY ASSESSMENT

AIMS

62. Militarily, the AIMS of the exercise were achieved.

a. Tempo

The pace and content of the exercise was stated to be greater than that experienced by the infantry element of the Combat Team in Battle Group and Formation exercises in 1971 and also greater than that experienced by the Combat Team Commander in the training seasons of 1966 and 1967. (The pace was necessary so that all the activities required could be included in the exercise in an appropriate context and sequence).

b. Minor Tactics

(i) Voice Control at section level presented problems. Section Commanders' spoken orders were hard to hear over the noise of battle. Greater reliance must be placed on hand signals. A tendency to close in and bunch presumably to hear better, or because of limited flank vision, was noted.

(ii) Radio Communications were good and were not degraded. Some difficulty was experienced using the A41 telephone type headset and this problem may exist with other telephone equipments.

- (iii) Verbal Orders and briefing were carried out successfully.
- (iv) Listening Posts and OI's found difficulty in hearing enemy movements; in some cases they were surprised by enemy patrols.
- (v) Patrols. These operated in open country with a good moon which made concealment difficult. In close country with more complete darkness, patrols operating in the fully protected condition will find considerable difficulty in moving silently; furthermore their ability to stop, look and listen is seriously curtailed. Restricted vision adds to the problem of night navigation

#### CAMOUFLAGE

63. Nets, hessian, and other equipments used for camouflage are likely to become contaminated and decontamination may prove to be extremely difficult.

#### VEHICLE MOVEMENT

- 64. a. Under a toxic threat it is essential that vehicle crews wear full NBC protection whilst mobile. There will be no time to stop and put on respirators during a chemical attack and there is presently no means of detecting a chemical agent whilst on the move.
- b. By day, there was a tendency for vehicles to bunch when moving in the closed down position; with more training the fault could be overcome.

#### CHEMICAL TRAINING

65. Special efforts were made to ensure that the Combat Team reached the required standard of training in chemical defence. However, when considered against the intensive nature of the exercise, these measures were inadequate. For example, although the pre-exercise training included sleeping in respirators, the time spent in practicing this function is now seen to have been inadequate. Some items of NBC defensive equipment, eg Resuscitator Portable NBC, Detector Kit, Chemical Agent, Residual Vapour (RVD), were not available for issue to the troops until after the exercise had commenced and consequently not all drills were adequately known and understood.

#### CHEMICAL ALARM SIGNAL

66. The present NATO system of banging two metal objects together for warning of a chemical attack is totally unsatisfactory. It is not sufficiently specific and in many instances does not provide for rapid warning.

CHEMICAL REPORTING

67. This was carried out promptly. Tank commanders and FOO used the NBC 1 proforma. Platoon and Section commanders reported chemical strikes as "contact report"; this procedure is acceptable at these lower levels of command provided that the essential elements of information to fit the NBC 1 (Initial report) are given.

CHEMICAL SOP's

68. Detailed unit SOP's were issued down to Section/Vehicle level and contained in a unit produced Commanders' Folder. These were in the form of AIDE MEMOIRES. The Unit Chemical SOP's were found to be inadequate, being too general and at too high a level, and are to be rewritten as a result of Exercise Jeremiah.

69. It is important that SOP's are familiar, not only to the organic members of any formation or unit but, if Battle grouping is to be practiced, a degree of standardization for all potential attachments and detachments must be enforced.

SUMMARY OF POST-EXERCISE EVALUATION

- 70. a. There was seen to be some degradation of performance when troops were dismounted. The Combat Team however showed little degradation in battle procedure and deployment when mounted.
- b. The general opinion was that the exercise showed that well trained soldiers could live and fight in a toxic environment but that some degradation of performance can be expected.
- c. Physical fitness played a vital part. The Combat Team went through an intensive fitness training course prior to the exercise and this contributed much to the well being and morale of the Combat Team and enabled it to complete an intensive exercise in very good physical condition and with high morale.
- d. The men of the Combat Team considered that when masked all the time they could fight in a toxic environment for a limited period only. If masking was reduced to two thirds of the time, and personal hygiene and eating and drinking could take place in an uncontaminated area, the Combat Team could fight on effectively.

## DISCUSSION AND CONCLUSIONS

GENERAL

71. The exercise demonstrated that well trained troops can operate effectively when wearing NBC protective clothing and equipment.

72. The concensus of opinion, of those who planned and directed the exercise is that the AIMS were met. However it would not have been possible to have satisfactorily conducted this exercise without the superb cooperation of the 2 Royal Anglian Combat Team nor without the special pre-exercise training programme.

73. Even with the high degree of troop cooperation it is evident from photographic and documentary records, that in a real situation there would have been a high rate of chemical casualties. There are various causes contributing to this opinion but they 'distil' down to the need for more abundant training in chemical defensive measures. There was some unauthorized removal of respirators, especially during the night, but the amount of "cheating" was insufficient to detract from the validity of the conclusions.

#### TRAINING

74. At present the act of donning NBC protective clothing and equipment is, to many soldiers, a novel experience. In a war situation this singular lack of familiarity with NBC equipment, compounded by the restrictive effects of wearing the equipment, can but lead to casualties. Regular training encouraging a familiarity with all items of the NBC protective equipment, together with the attainment of a good physical fitness standard achieved whilst wearing the equipment, will help to considerably reduce casualty figures. Further, by achieving a suitable standard of physical fitness coupled with equipment familiarization training, the soldier will be better enabled to perform his military tasks with the minimum of restrictive influences attributable to his NBC equipment.

75. It was demonstrated, during the pre-training for Exercise Jeremiah, that a suitable standard of physical fitness to aim at is the completion of a minimum of 12 circuits of a two hundred meter track, wearing NBC protective clothing and respirator, in a time of twelve minutes and Volume II of the repcrt should be studied for suggestions for achieving the recommended standard.

76. Although the pre-exercise training included sleeping in respirators, the time spent in practicing this function is now seen to have been inadequate.

77. The standards for individual and unit training in the principles of NBC defence training, as laid down in NBCDT Pamphlet No 8 whilst excellent in their own right, are likely to be inadequate if they are to be regarded only as the training for an annual test. The soldier will need to be as familiar with chemical defence procedures as he is with his other battle skills and this familiarity must include night time operations and be obtained in various climatic extremes.

#### EXERCISE UNREALISM

78. A chemical training exercise can never equate to the reality of operational conditions and, in assessing the results of such an exercise, it is essential to separate those lessons which would apply to operations and those which arise from exercise conditions. Several

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measures arose during the course of the exercise which created an air of artificiality and unrealism and should be catered for in the planning of future exercises.

CHEMICAL ATTACK SIMULATION

79. Chemical attack simulation was limited in scope and at times, failed to provide an adequate challenge. The chemical threat facing our troops is such that the potential enemy has a choice of agents, varying in degrees of persistency, and a variety of delivery means. Surprise attacks can be delivered rapidly but not necessarily covertly. There is in training a need to simulate the differing types and means of chemical attack thus enabling the required aim for each chemical situation to be achieved. Account has already been taken of the shortcomings noted and NBC Training Note No 8 - "The Conduct and Control of Chemical Exercises" has been published as guidance pending the revision of existing training pamphlets.

CHEMICAL CASUALTIES

80. Prior to the exercise casualty figures were worked out in accordance with assessment tables. It was hoped that these could be checked on the ground by practical assessment but this was not possible due to the limitations of the chemical simulation devices (which meant usually that the troops had ample warning of attack unlike real situations) and the fact that there is, at present, no satisfactory way of assessing lapses of personal protective 'ills.

PROBLEMS CREATED BY CONTAMINATION WITH PERSISTENT AGENT

81. The contamination of vehicles and equipments with liquid persistent agent, and vapour given off by the contamination, will cause all men who operate in or with those equipments to remain fully protected until decontamination or decay of the agent takes place. This measure of protection may also be needed after the move of those vehicles and equipments to what otherwise had been proved to be a toxic-free environment,

82. If men are required to remain fully protected for longer than five days, problem areas, not encountered in Exercise Jeremiah, may emerge. There is also a need to consider operational decontamination of equipment; until techniques have been developed to counteract the more toxic of the persistent agents it is possible that relief in the field will necessitate "clean troops" inheriting the "dirty battlefield".

TROOPS' STATE OF HEALTH

83. The level of medical fitness remained remarkably high throughout the exercise. The only significant problem was a skin condition, of hands and feet, induced by the impermeable protective overboots and gloves. There is a need for greater attention to the fitting of boots and the care of feet and, if NBC protective gloves have to be worn for any length of time, care of hands will also be an important factor. An additional scaling of glove inners would be helpful.

STANDING OPERATING PROCEDURES

84. The final version of 2 Royal Anglian SOP's (NBC) are to be found at Annex K, Volume II. The difficulties in producing a set of SOP's equal to all situations are immense, but it is considered essential that SOP's must be common for all elements of a Combat Team, Battle Group or Formations.

TACTICAL EXERCISE

85. The exercise was of necessity planned to have a somewhat unrealistically high content and to move at a fast pace. However, there were only minor changes to the original forecast of events and the Combat Team completed all of their various battle procedures.

86. Assessment of the results shows that there was little degradation in battle procedure and deployment when mounted. There was some degradation of performance, however, when troops were dismounted.

87. It is important to note that although there is indeed a perceptible slowing in foot mobility, and in work rates at certain tasks, at no time did a commander or umpire, attribute any loss of objective to these causes.

88. Having ascertained that NBC protective clothing and equipment imposes a degree of degradation of performance in certain tasks, what is the significance of the information? Is the degradation likely to assume such importance that it will have an effect on the progress or outcome of a military action? In the design of Exercise Jeremiah it was decided to test the hypothesis that it was necessary to look beyond individual performance and examine the consequence of several individuals, or groups, exhibiting a decrement in performance at one and the same time. If it could be seen during the exercise that, for all phases of battle examined, commanders at all levels could maintain command and control, the troops could identify and engage targets, and communications could be maintained, it was unlikely that there would be a significant accumulative effect from the various performance decrements.

89. It was postulated that, with appropriate training, performance of most of the combat skills, normally affected by wearing NBC clothing and equipment, would be improved to such a degree that, if any degradation in individual performance was still detectable, it would be unlikely to have a significant effect on the outcome of the tactical results of the exercise.

90. The intensity of the exercise coupled with loss of sleep caused some deterioration in mental and physical abilities but the extent to which the NBC protection per se contributes to this effect cannot be separated from the total effects of the exercise on the men. One of the questions posed at the post-exercise debrief of forty Officers and NCOs was "Are the men under your command any the 'worse for wear' than after any other five day exercise?". Nineteen of those questioned gave "yes" as the answer (47.5%) and twenty-one answered "No" (52.5%).

91. Under the conditions pertaining to the five day field exercise (Exercise Jeremiah), it can be concluded that in principle the individual degradation demonstrable at specific tasks, is unlikely to have an overall effect on any of the various phases of battle. However, it could prove disastrous to extrapolate this conclusion for less highly trained and motivated troops or for troops in more severe climatic extremes or for troops caught unaware of a toxic threat.

MASKING

92. The length of time that soldiers can realistically be required to mask must still be a matter of some conjecture. Certain guidelines, however, are apparent; a soldier will certainly require to shave once every seventy-two hours or the integrity of the respirator seal will be lost. If a total of one to two hours in each twenty-four could be made available for unmasking and respite for the hands, it is probable that a well trained soldier could exist for five days on the toxic battlefield and in a temperate climate ingest sufficient water and food necessary for his well being. If the toxic conditions are such that it is necessary to conduct the NBC eating and drinking drills it is highly improbable that troops could be expected to remain in a toxic atmosphere for longer than forty-eight hours without respite. Until such time as a more challenging training aid is available, these figures are likely to remain a matter of conjecture, at least for troops operating under realistic field conditions.

93. It was concluded that, in addition to the safety rule, there are other specific occasions when the wearing of a respirator will be obligatory, ie after chemical munitions have been used or are likely to be used, viz:

- a. when moving in the battlefield area
- b. troops resting or sleeping
- c. inhabiting contaminated vehicles
- d. manning noisy equipment which could obscure an alarm
- e. patrol activities.

CHEMICAL ALARM SIGNAL

94. Troops cannot rely on the present NATO Alarm signal. There is a requirement for an improved system and it is suggested that the feasibility of an audio-visual device, preferably fired from an existing weapon such as the Pistol Signal, be investigated.

SPECIAL EFFECTS

95. The exercise was not designed in order to precisely quantify the effect of wearing NBC protective clothing on specific activities; a closely controlled trial is more appropriate to answer this type of problem. However, one operational activity, patrolling, was called

into question and this is an area that may merit further investigation. Only one patrol was criticised out of five, and it may well be that further training in movement at night could have reduced some of the problem areas encountered (eg restriction of hearing ability due to the hood of the protective suit, limited arc of vision due to the respirator).

#### NBC CLOTHING AND EQUIPMENT

96. The exercise highlighted various points concerning NBC equipment where alterations are required. Remedial action is in hand with many of these points and others will be taken into account when designing future equipment; the exercise was thus of great value in presenting an opportunity to observe the use of chemical defensive equipment on a large scale and in realistic exercise conditions. A summary of the main points is as follows:

- a. S6 Respirator. A few soldiers reported headaches, blurring of vision and disorientation but the majority quickly learned to live with their respirator and eventually to sleep in it. Some of the lower harness straps showed wear and this problem has been investigated further since the exercise.
- b. Suit Protective NBC. The Combat Team wore the Mk 2 NBC Suit which although it presented a few problems, these were only of a minor nature. The enemy wore prototype Mk 3 NBC suits, and the experience from the exercise enabled design alterations and improvements to be made to the suit prior to its acceptance later in 1972.
- c. Glove Protective NBC. Gloves were the most criticised item of NBC equipment particularly as regards comfort (hands became excessively cold), difficulties in obtaining the correct size, strength and tactility. See paragraph 83. Information obtained has been useful in current work on new solutions to this very difficult problem of hand protection.
- d. Overboots NBC. This was the first occasion in which NBC overboots have been used on a tactical exercise. Although an encumbrance they produced surprisingly few adverse comments. Such as there were, concentrated on the laces (the material for which is being changed) and the condition of the feet at the end of the exercise. It is apparent that the wearing of overboots makes the need for daily foot hygiene more necessary than ever.
- e. Detector Paper. It was shown that troops must change their detector paper at least every 24 hours as otherwise it gets dirty and wet and colour changes are not obvious. Detector paper should be displayed on a flat surface on vehicle decks within the driver's and commander's vision. There may be a need for larger size sheets of detector paper for use on flat surfaces and this suggestion could merit further study.

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- f. Decontamination Apparatus Portable. This was another item of equipment new to the troops. The apparatus was used by them at the end of the exercise to decontaminate their vehicles. The results were adequate when consideration is given to the lack of familiarity. No problems were found with the equipment except that there was little, if any stowage space for it on or within the vehicles. Scaling of this equipment and its stowage on various vehicles requires to be examined by Arms/Services Directors.
- g. Collective Protection Shelter. A prototype collective protection shelter was given a limited trial on the exercise and valuable information was obtained on the concept.

CHEMICAL TRAINING AIDS

97. The following training aids were used.

- a. Light Aircraft Spray. This is useful for spraying CATM but when used from a helicopter is an unrealistic means of delivery.
- b. Simulator Projectile Airburst Liquid (SPAL). This is a 'pop up' bursting 1 litre bottle filled with CATM. When used in reasonable quantities it is effective but does require prior planning in its use and careful tactical direction of the troops.
- c. CATM. This is the mixture used to simulate a liquid agent attack. It has the advantage of being harmless and marking detector paper but does not simulate a real agent or provide a physiological penalty against badly protected troops.
- d. CS Devices. Various CS devices were used. From the exercise it has become clear that a CS device to simulate an on-target attack is required. It is possible that the Anti-Riot Bursting CS grenade may be able to fill this role.

SCALING OF NBC CLOTHING AND EQUIPMENT

98. The availability and re-supply of NBC clothing and equipment should be scaled as for operations so that correct drills, procedures, and re-supply can be carried out. The enforced wearing or use of unserviceable clothing results in many wrong impressions and reflects adversely on an understanding of the hazards of NBC attack and the standard of familiarisation training.

CONCLUSIONS IN RELATION TO THE AIMS OF EXERCISE JEREMIAH

99. AIM (a). To study the effect on the military performance of All Arms wearing full NBC protective clothing and equipment on a battlefield continuously contaminated by chemical agents.

The exercise has demonstrated that with some minor equipment modifications (already set in train), a well trained soldier could

live and fight in a toxic environment in a temperate climate such as to be found in NW Europe. Military commanders at all levels of the Combat Team were able to complete their various military tasks and the degree of degradation in military performance was not sufficient to perceptibly interfere with a commander's normal course of action. Due to a lack of a challenging training agent, it was difficult to maintain a realistic picture of a constant threat and there was some unauthorised removal of respirators.

100. AIM (b). To decide the extent to which a well trained soldier can live and fight in a toxic environment with the equipment now available.

It is considered highly probable that a well trained soldier could live and fight in a toxic environment with the equipment presently available to him; however, the emphasis is on the well trained soldier and the approach to the training cannot be casual. If the toxic environment were caused by a persistent agent, there are certain aspects of operational procedures which require further examination, especially if the soldier is to be required to remain in the toxic environment for more than forty-eight hours. Under conditions of a constant toxic threat, good morale and physical fitness coupled with a complete understanding of his SOP's and familiarity with and confidence in his equipment, will be key features in the soldier's survival.

101. AIM (c). To determine the need for collective protection for rest and relief purposes.

With adequate training, a soldier can sleep whilst masked and could probably achieve sufficient respite on the battlefield without the need for collective protection, providing the attack was from non-persistent agent. If the attack is from a persistent nerve agent then there is seen to be a need for some method of individual respite or shelter preferably erected in a basement or building. There would be a need to retire to such a shelter at least one to two hours in each twenty-four after the first forty-eight hours in action.

## RECOMMENDATIONS

## 102. IT IS RECOMMENDED THAT:

- a. A standard of "physical fitness", to be achieved whilst wearing NBC protective clothing and equipment, forms part of the annual defence test for trained soldiers and that it be written into the DAT's directive as a required standard for All Arms and, unlike the PE test, this should not be limited by age and it should be mandatory for all cap badges.
- b. Training to achieve the "physical fitness" standard and the requirements laid down for individual and unit training, in the principles of NBC defence training (NBC DT Pamphlet No 8) should not be considered as a separate form of training but should be fully integrated into all aspects of training for war. Training should include, at least once a month, one night sleeping in a respirator and field exercises should include two to three nights sleeping in a respirator.
- c. A study be conducted to determine recommendations for standing operating procedures for living and fighting in APCs and AFVs contaminated with a persistent agent and that human factor considerations form part of the study.
- d. Research be continued to develop means of supplementing the present drills for eating and drinking in a chemical environment.
- e. Research be continued into developing improved chemical agent training systems.
- f. Further work be carried out on quantifying the hazards from vehicles and equipment contaminated with persistent chemical agent. This should be particularly concerned with the problems arising from the transfer of contaminants to the inside of vehicles, CPs and hides.
- g. Further work needs to be conducted on improved comfort for chemical protection of the hands and feet.
- h. Work on the development of Collective Protection should continue.
- i. There is a need for further exercises at least at Combat Team level and they should continue to study the problems of conducting military operations in a toxic environment. In particular, the problems of detection and identification of toxic hazards arising from the limitations of the training expedients requires investigation.

## ACKNOWLEDGEMENTS

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The chief umpire, Major G A A-R-West and the umpire team responded magnificently to a difficult task. Their cooperation during the exercise contributed to its smooth running and to the value of the information obtained.

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